1999 AGU Fall Meeting
San Francisco, CA, USA
13–17 December 1998

GPS Observations of Extreme Variations of the High Energy Radiation Belt Radial Profiles During the May 10-13, 1999 Period

J. C. Ingraham
T. E. Cayton
R. H. W. Friedel and
M. G. Tuszewski
LOS ALAMOS NATIONAL LABORATORY,
LOS ALAMOS, NEW MEXICO, USA

Los Alamos
NATIONAL LABORATORY

Contents

A. Overview

Energetic particle detectors on three GPS satellites monitor the radiation belts simultaneously at several local times with a time resolution of three hours per cut through the radiation belt per satellite.

During the period May 10-12 all satellites observed an extremely large trapping region in the inner magnetosphere, with relativistic electron fluxes extending beyond $L = 10$ in the midnight sector. During normal conditions we rarely observe particles beyond $L \sim 7$. We also observe large flux asymmetries between the noon, dawn, dusk and midnight sectors, a measurement for which GPS is particularly well suited.

The small magnetic storm on May 13 ($Dst = -57$) flushed out all particles in the GPS energy range (0.2 – 3.2 MeV) on L-shells greater than $L = 5$. This is an extreme example of particle loss from an abnormally inflated magnetosphere.

C. Rationale

The main factor determining the outer extend of the energetic radiation belts are breakdown of trapping at the dayside magnetopause. Particle drift orbits intersecting the magnetopause are effectively removed from that drift shell. For relativistic particles, drift periods are short (10s of min) thus even transient dayside compressions can have an effect. Quiet conditions during which the magnetopause is further out AND is not varying much increases the trapping region. These quiet times are ideal to investigate filling of these regions by particles that are not normally trapped in this region.

Magnetopause position here is estimated from solar wind measurement from the ACE spacecraft (courtesy John Steinberg).

$$R_{MP} = \frac{(2B_s)^{1/3}}{2\mu_o \rho V^2)^{1/6}} \qquad (1)$$

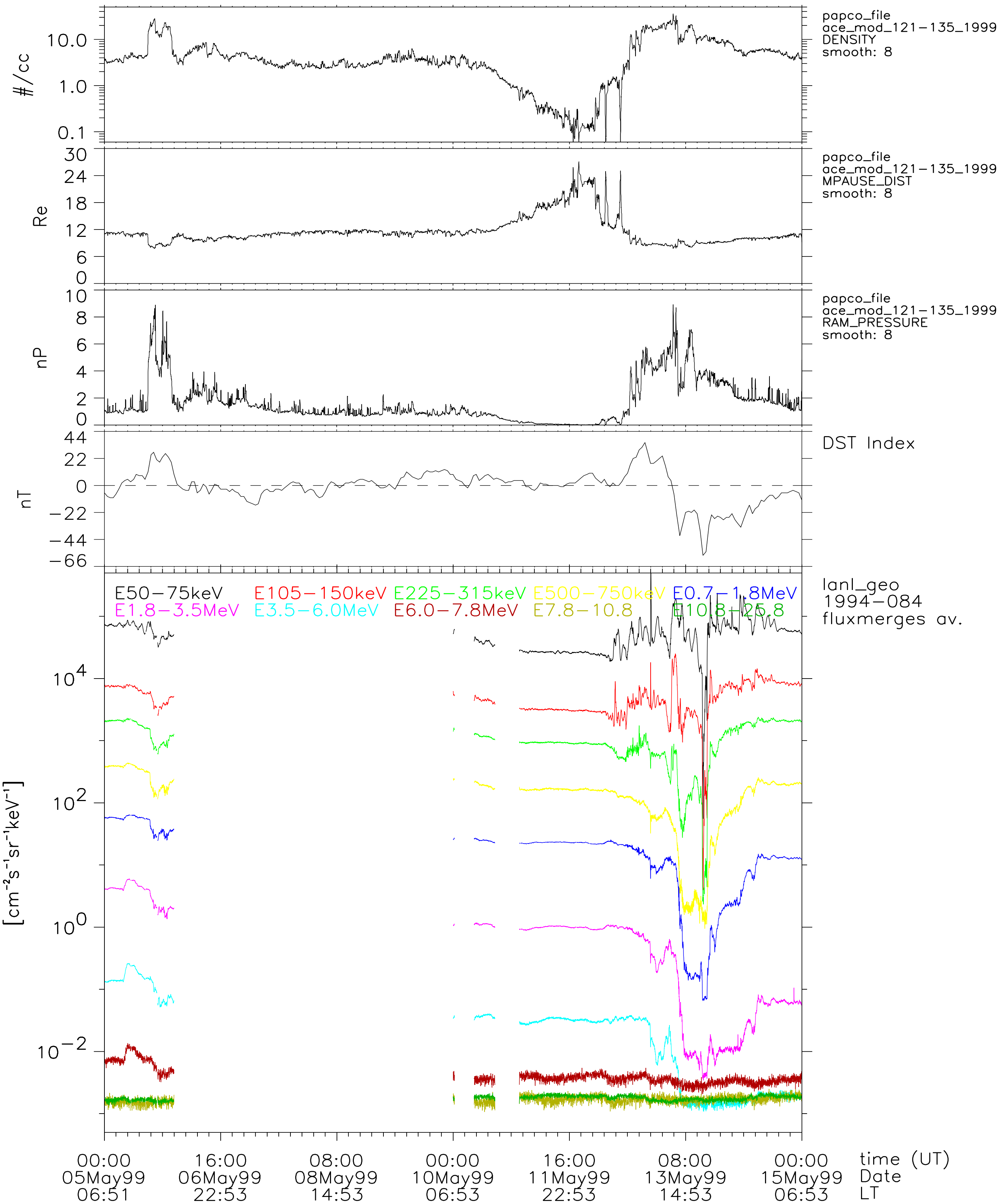
where B_s is the dipole magnetic field strength at 1 R_E, V is the solar wind speed and ρ the solar wind density.

The Ram pressure of the solar wind is defined as

$$P_{RAM} = m_p \rho V^2 \qquad (2)$$

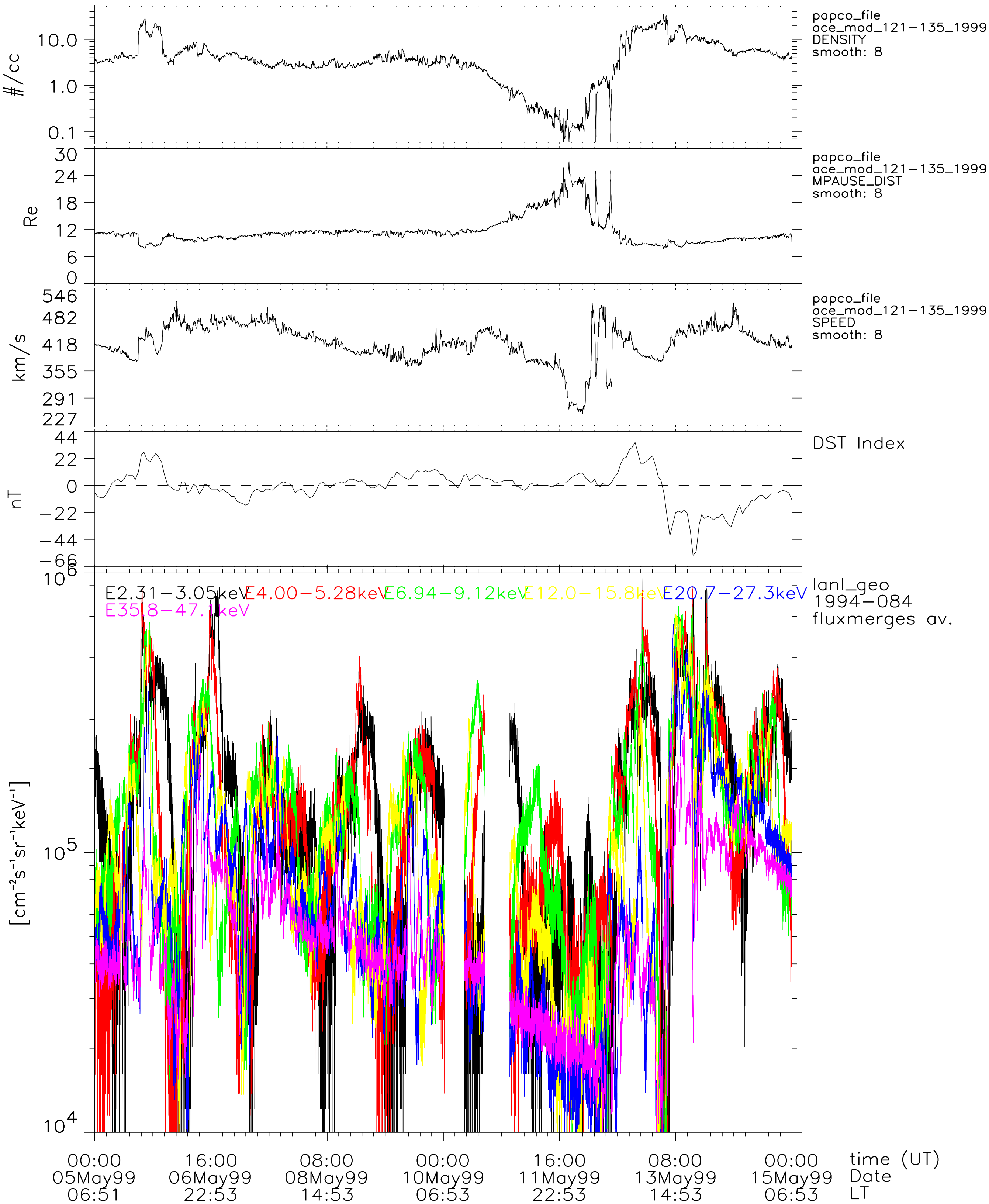
where m_p is the proton mass.

D1. Geosynchronous environment Energetic particles



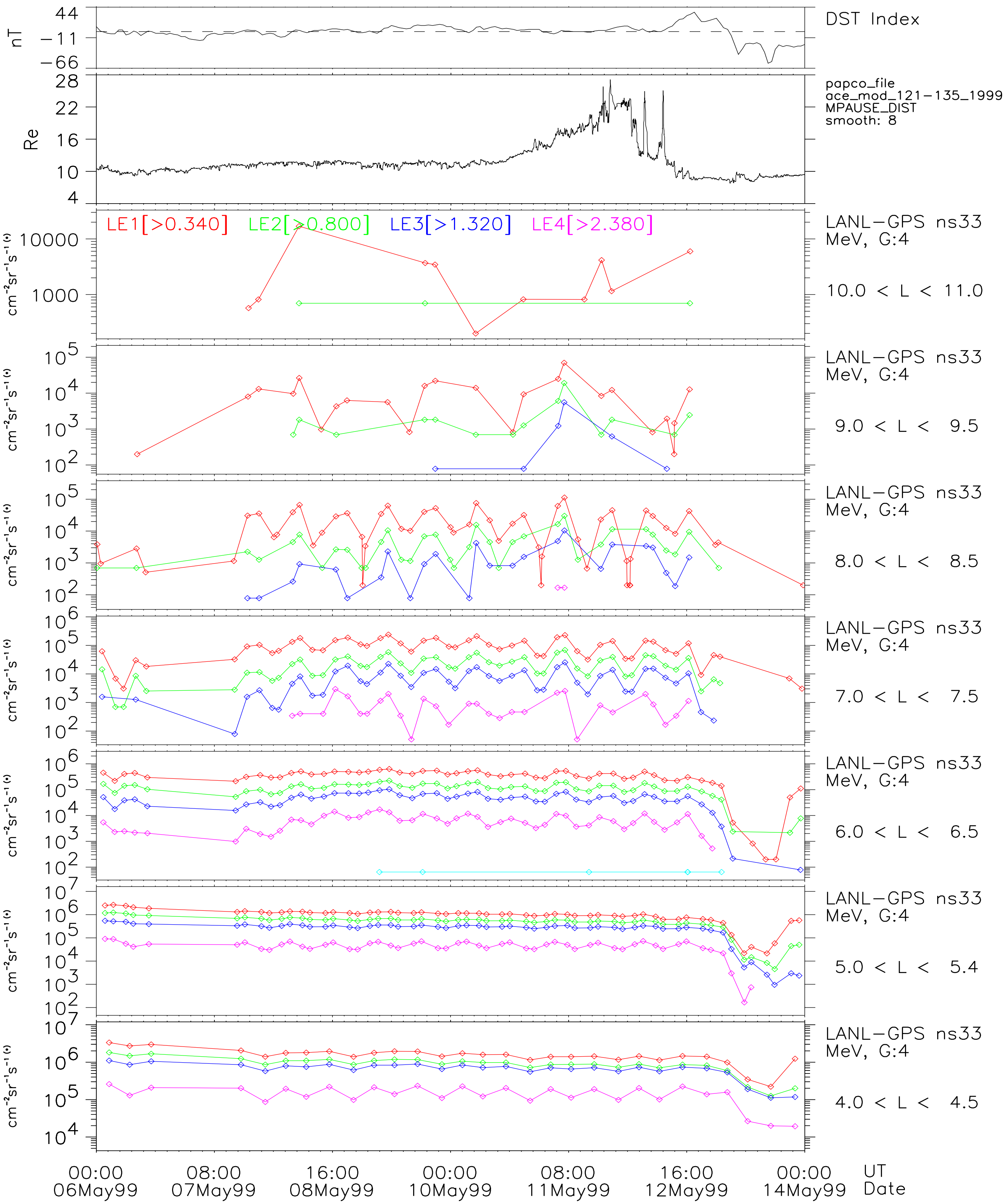
D2. Geosynchronous environment Plasma sheet particles

The Energetic Particle Team at Los Alamos National Laboratory

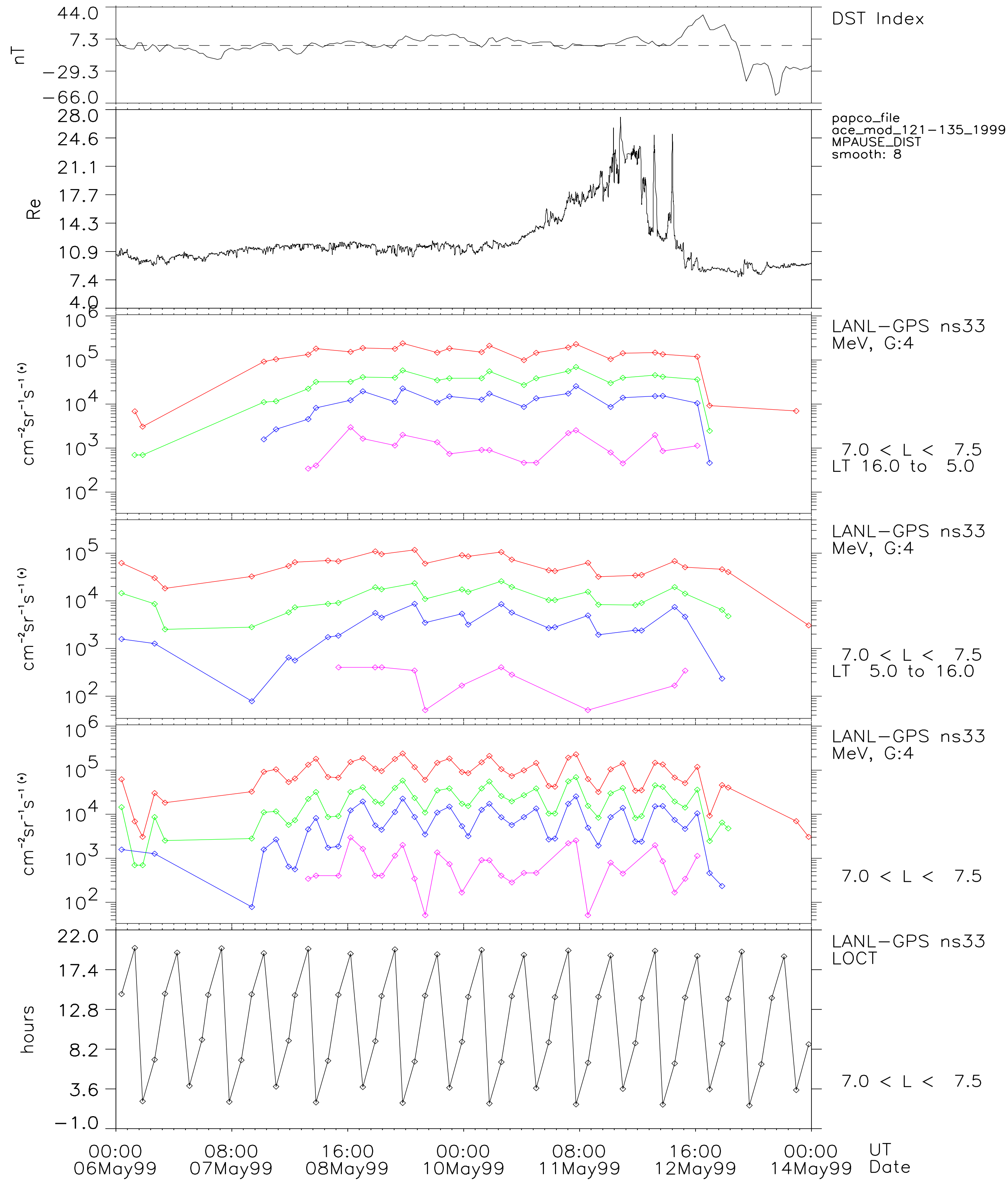


Los Alamos NATIONAL LABORATORY

E1. GPS overview - ns33

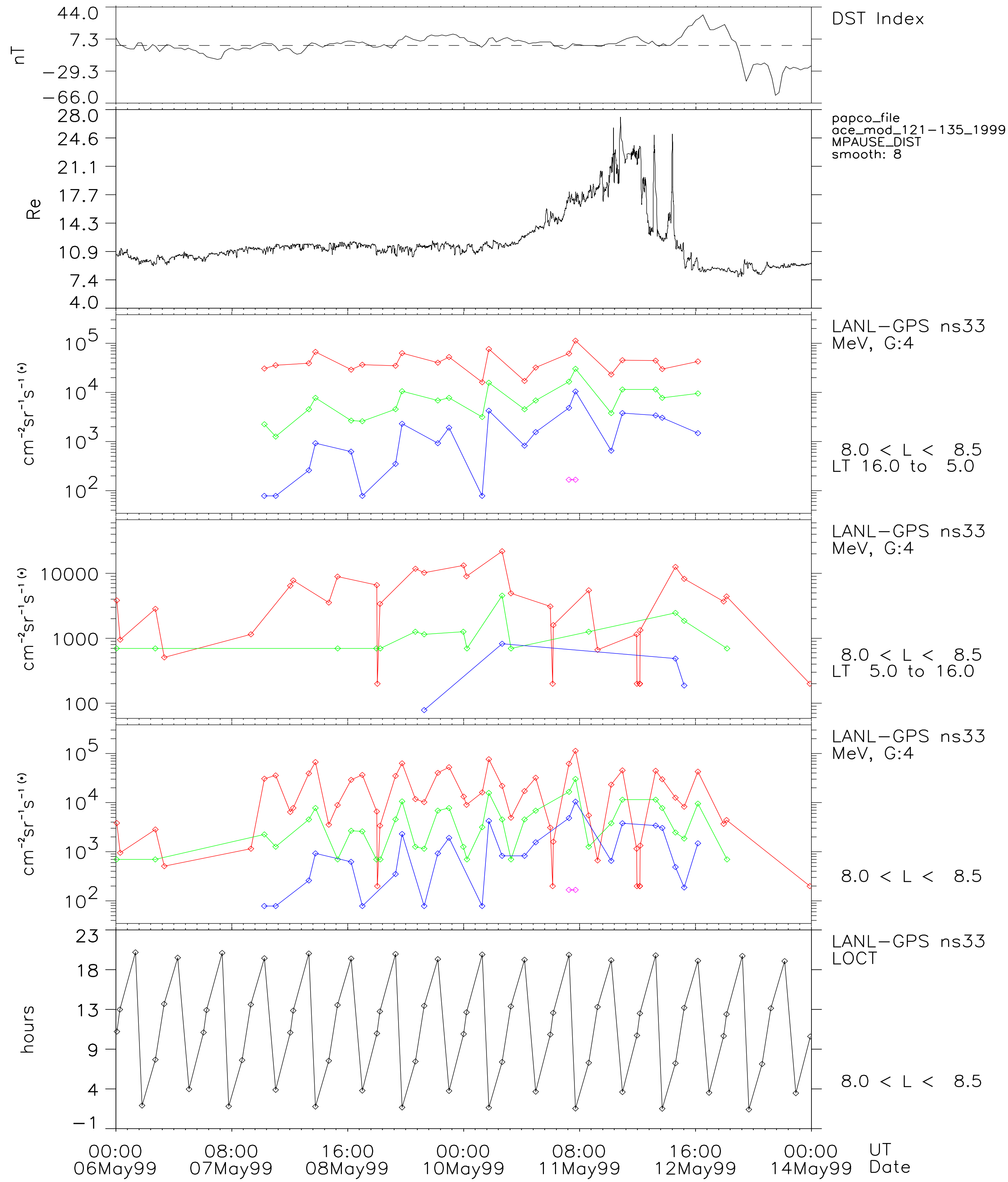


E2. GPS ns33 (L 7.0–7.5)

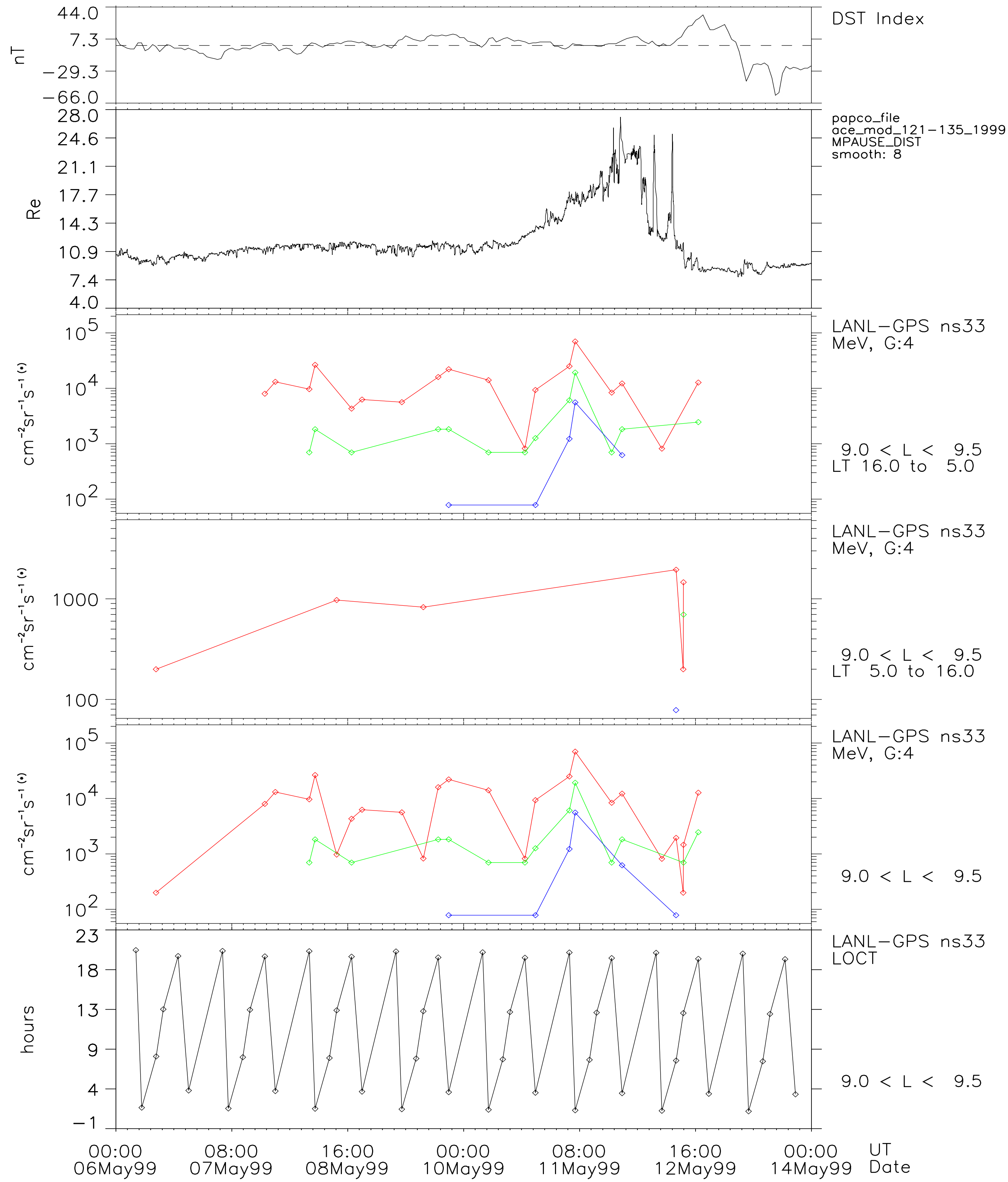


Los Alamos
NATIONAL LABORATORY

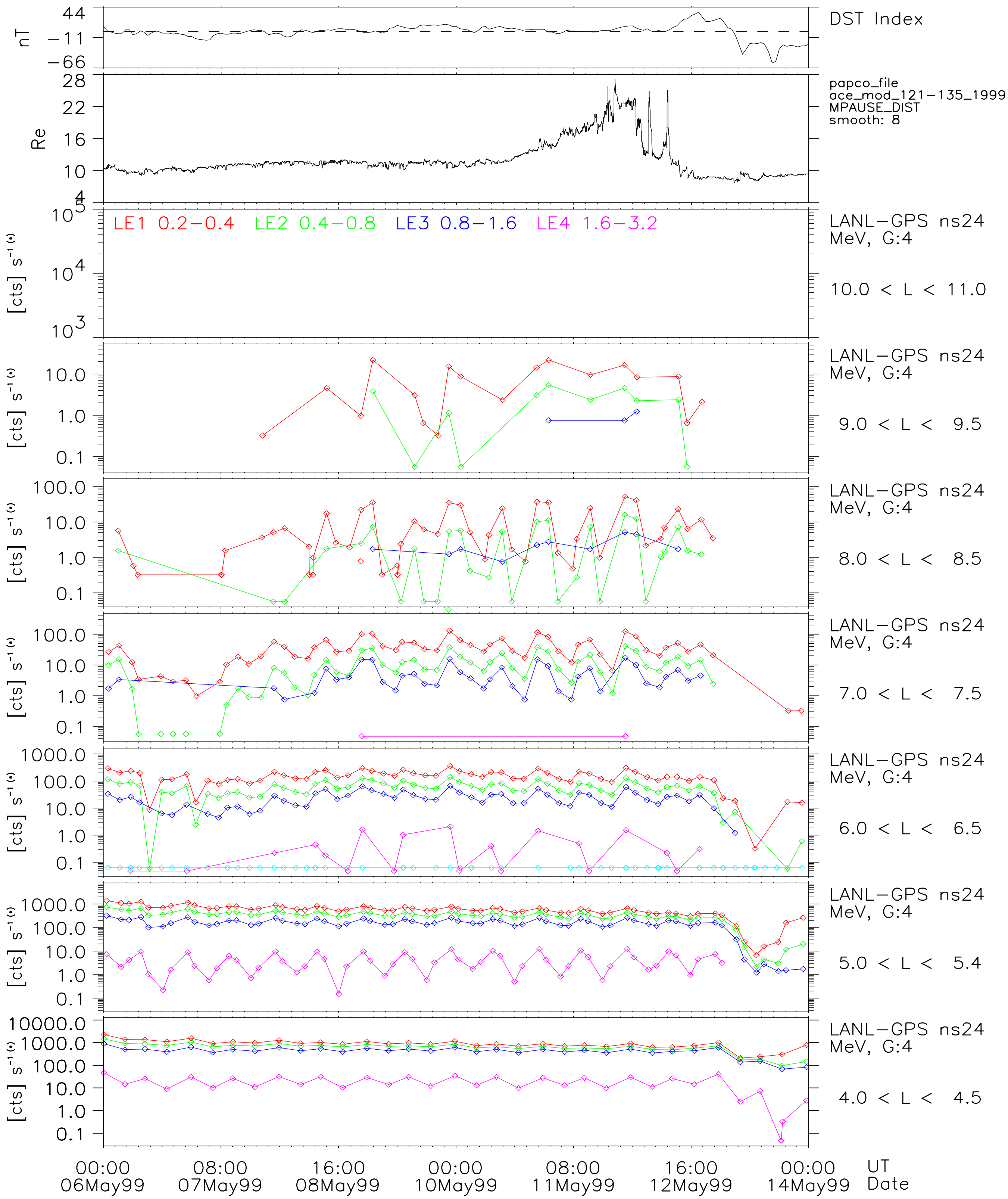
E2. GPS ns33 (L 8.0–8.5)



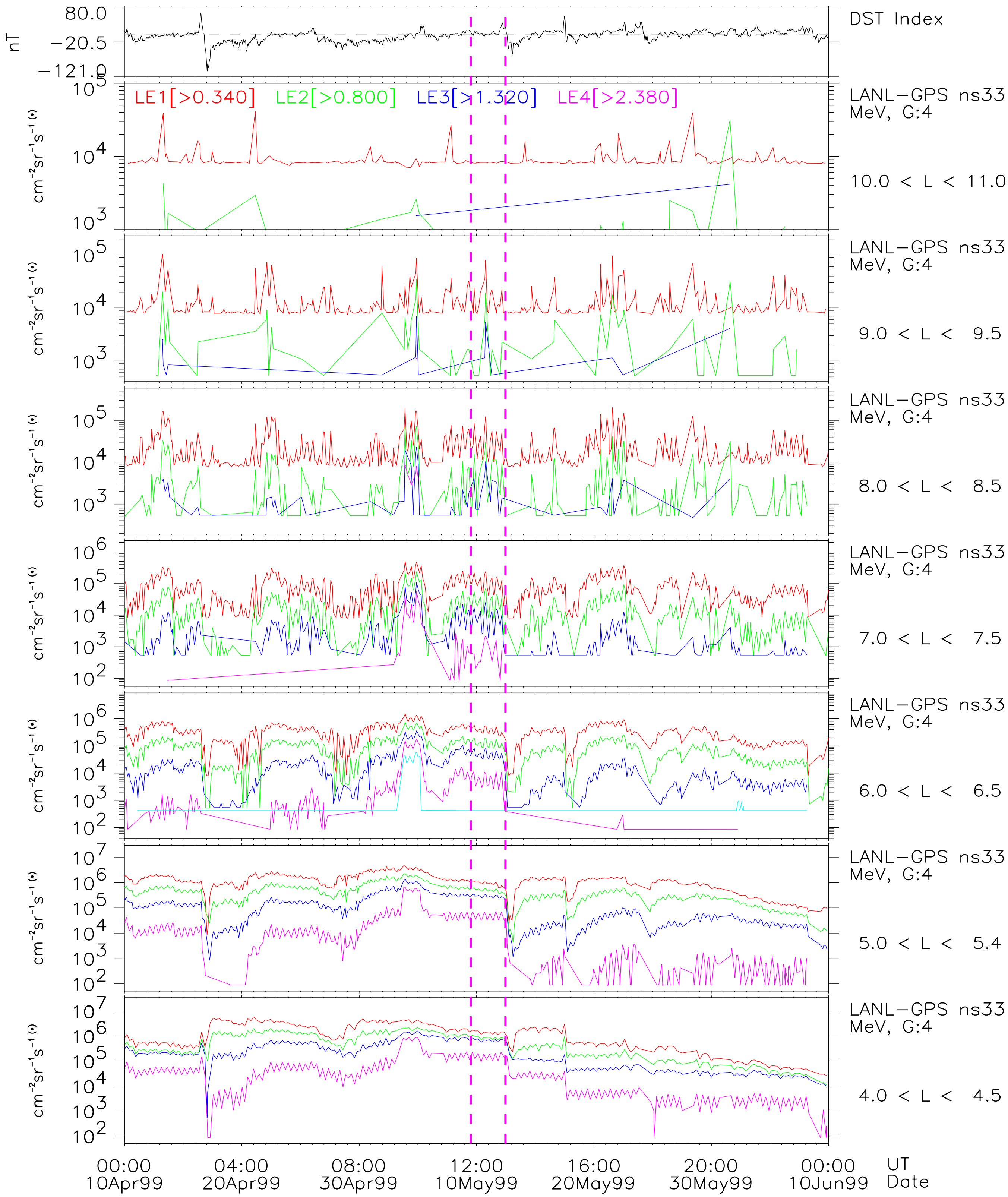
E3. GPS ns33 (L 9.0–9.5)



E4. GPS overview - ns24



F. GPS Long term comparison



G. Summary

- There is no effect seen at geosynchronous orbit for energetic particles - very slight decrease of fluxes.

- Classical diurnal variations of fluxes is absent - no drift shell splitting - very dipolar field at geo.

- Very low plasmasheet densities measured at geo. Could be due to absent convection - no access to geo

- GPS sees a slight flux decrease at $L < 6$, but a slight flux increase at $L > 6$.

- Energetic particle behavior is consistent with very quiet time behavior. NO special signature is observed during the extra low density times at high L - could be in part due to sensitivity issues, and being far off the equator.

- Newly "closed" drift shells should become populated by diffusion. GPS is not sensitive enough to measure this - other instruments?